

Appln. No. 10/776,715  
Response dated September 11, 2007  
Reply to Office Action of June 11, 2007

RECEIVED  
CENTRAL FAX CENTER

SEP 11 2007

**Amendments to the Claims:**

Please cancel claims 2, 4, 14, 26, 28 and 38 and amend claims 1, 5-12, 15, 20, 22, 25, 29-35, 39, and 44 as follows. The following listing of claims will replace all prior versions, and listings, of claims in the application.

**Listing of Claims:**

Claim 1 (Currently Amended). A method operative for asynchronously mirroring a selected data object from at least one local storage device (SDL) into at least one remote storage device (SDRx), the at least one local storage device being  
5 coupled to a first processing facility (HL), and the at least one remote storage device being coupled to a second processing facility (HR), and where the at least one local storage device, the at least one remote storage device, the first and the second  
10 processing facility are coupled to a network connectivity comprising pluralities of users, of processing facilities and of storage devices, the method comprising the steps of:

running a mirroring functionality in the first and in the second processing facility, the mirroring functionality comprising:

Appln. No. 10/776,715  
Response dated September 11, 2007  
Reply to Office Action of June 11, 2007

15 a freeze procedure applied for freezing the selected  
data object at any desired instant in time as a source volume  
(SV), and

a copy procedure for copying the frozen selected data  
object into the at least one remote storage device,

20 ~~creating simultaneously to the application of the freeze and~~  
~~copy procedure a local auxiliary volume in the local storage~~  
~~device to which updates addressed to the frozen selected data~~  
~~object are redirected, of a remote volume having a same size as~~  
~~the frozen source volume in the remote storage device, forming in~~  
25 ~~the local storage device a resulting source volume including the~~  
~~frozen source volume and the local auxiliary volume, and copying~~  
~~the frozen source volume to the remote volume,~~

~~repeating successively the freeze and copy procedure by~~  
~~freezing a last created local auxiliary volume and simultaneously~~  
30 ~~creating a next local auxiliary volume to which updates addressed~~  
~~to the frozen data are redirected, creating a next remote volume,~~  
~~and adding the last created local auxiliary volume to a last~~  
~~formed resulting source volume to form a new resulting source~~  
~~volume, and copying a before last frozen local auxiliary volume~~  
35 ~~to a last created remote volume,~~

permitting use and updating of the selected data object in  
parallel to running the mirroring functionality, and

Appln. No. 10/776,715  
Response dated September 11, 2007  
Reply to Office Action of June 11, 2007

commanding, by default, repeated run of the mirroring  
functionality for copying updates to the selected data object,  
40 unless receiving a command for a mirroring break,

whereby the selected data object residing in the at least  
one local storage device is copied and sequentially updated into  
the at least one remote storage device, and ~~whereby auxiliary  
volumes frozen by successive freeze procedures contain,~~  
45 ~~respectively, successive updates directed to the data object~~  
wherein the mirroring functionality further comprises the steps  
of:

applying the freeze procedure for freezing the selected data  
object as a source volume,

50 creating at least one local auxiliary volume to which  
updates addressed to the selected data object are redirected, the  
selected data object corresponding to one of the at least one  
local auxiliary volume,

creating at least one remote volume in each of the at least  
55 one remote storage device, to correspond to each one local  
auxiliary volume created,

forming in the at least one local storage device, of at  
least one resulting source volume comprising the frozen selected  
data object and the at least one local auxiliary volume, and

Appln. No. 10/776,715  
Response dated September 11, 2007.  
Reply to Office Action of June 11, 2007

60 applying the copy procedure for copying the frozen selected data object from the at least one resulting source volume into the at least one remote storage device.

Claim 2 (Cancelled).

Claim 3 (Original). The method according to Claim 1, further comprising:

applying the mirroring functionality simultaneously to more than one data object.

Claim 4 (Cancelled).

Claim 5 (Currently Amended). The method according to Claim [[2]] 1, wherein the mirroring functionality further comprises:

applying the freeze procedure for simultaneously freezing more than one data object.

Claim 6 (Currently Amended). The method according to Claim [[2]] 1, wherein the mirroring functionality further comprises:

applying the copy procedure to ~~simultaneously~~ copy simultaneously more than one frozen selected data object.

Appln. No. 10/776,715  
Response dated September 11, 2007  
Reply to Office Action of June 11, 2007

Claim 7 (Currently Amended). The method according to Claim  
[[2]] 1, further comprising:

~~simultaneously~~ mirroring simultaneously one single data  
object residing in one local storage device into more than one  
5 remote storage device.

Claim 8 (Currently Amended). The method according to Claim  
[[2]] 1, further comprising:

~~simultaneously~~ mirroring simultaneously more than one single  
data object from one local storage device into one remote storage  
device.

Claim 9 (Currently Amended). The method according to Claim  
[[2]] 1, further comprising:

~~simultaneously~~ mirroring simultaneously a plurality of  
single data objects residing respectively in a same plurality of  
5 local storage devices into one remote storage device.

Claim 10 (Currently Amended). The method according to Claim  
[[2]] 1, further comprising:

Appln. No. 10/776,715  
Response dated September 11, 2007  
Reply to Office Action of June 11, 2007

~~simultaneously~~ mirroring simultaneously a plurality of  
single data objects residing in one local storage device  
5 ~~respectively~~ into a plurality of remote storage devices.

Claim 11 (Currently Amended). The method according to Claim  
[[2]] 1, further comprising:

~~simultaneously~~ mirroring simultaneously one single data  
object residing in each one local storage device out of a  
5 plurality of local storage devices into one remote storage  
device.

Claim 12 (Currently Amended). The method according to Claim  
1, wherein mirroring further comprises:  
at a selected point in time:

starting a mirroring cycle,  
5 freezing the selected data object,  
creating at least one local auxiliary volume (AVL) in the at  
least one local storage device (SDL) and at least one remote  
volume (RV) in the at least one remote storage device (SDRx),  
forming at least one resulting source volume comprising the  
10 frozen selected data object and the local auxiliary volume (AVL),  
and  
after the selected point in time:

Appln. No. 10/776,715  
Response dated September 11, 2007  
Reply to Office Action of June 11, 2007

copying the frozen selected data object from the resulting  
source volume into the at least one remote volume until ~~copying~~  
15 ~~is completed~~ completion of copy,

redirecting to the local auxiliary volume the updates  
addressed to the frozen selected data object,

permitting use of the selected data object during mirroring,  
by allowing read and write operations associated with the  
20 resulting source volume, and

repeating a next mirroring cycle by default command, after  
completion of copying to the at least one remote storage device,  
unless receiving a command for mirroring break.

Claim 13 (Previously Presented). The method according to  
Claim 12, wherein mirroring further comprises:

starting a next mirroring cycle at a next point in time  
occurring after completion of copying to the at least one remote  
5 storage device,

freezing the resulting source volume,

creating an ultimate local auxiliary volume in the local  
storage device and an ultimate remote volume in the at least one  
remote storage device,

Appln. No. 10/776,715  
Response dated September 11, 2007  
Reply to Office Action of June 11, 2007

10 forming an ultimate resulting source volume comprising the  
penultimate resulting source volume and the ultimate local  
auxiliary volume , and  
after the next point in time:

15 copying the penultimate local auxiliary volume into the  
ultimate remote volume, and,

redirecting to the ultimate local auxiliary volume of the  
updates addressed to the frozen selected data object,


20 permitting use of the selected data object during mirroring,  
by allowing read and write operations associated with the  
ultimate resulting source volume, and  
after completion of copy into the ultimate remote volume:

synchronizing the penultimate local auxiliary volume into  
the frozen selected data object,

25 synchronizing the at least one ultimate remote volume into  
the penultimate remote volume by command of the second processing  
facility (HR), and

repeating, by default command, of a next mirroring cycle  
after completion of copy to the at least one remote storage  
device, unless receiving command for mirroring break.

Claim 14 (Cancelled).





Appln. No. 10/776,715  
Response dated September 11, 2007  
Reply to Office Action of June 11, 2007

Claim 15 (Original). The method according to Claim [[14]]  
13, wherein mirroring further comprises:

storing in the at least one remote storage device of a  
complete mirrored copy of the selected data object comprising  
5 updates entered thereto at the time when copy of the before to  
penultimate local auxiliary volume was completed.

Claim 16 (Original). The method according to Claim 1,  
wherein:

mirroring is applicable to a data object selected from the  
group consisting of data volumes, virtual volumes, data files,  
5 system files, application programs, operation systems, data  
structures, and data base records.

Claim 17 (Original). The method according to Claim 1,  
wherein:

mirroring is applicable to a network connectivity selected  
from the group consisting of local area networks, wide area  
5 networks and storage area networks.

Claim 18 (Original). The method according to Claim 1,  
wherein mirroring further comprises:

Appln. No. 10/776,715  
Response dated September 11, 2007  
Reply to Office Action of June 11, 2007

repeating operation of the mirroring functionality at  
discrete repetition intervals of time defined as lasting at least  
5 as long as duration of copying of the ultimate local auxiliary  
volume to the ultimate remote volume.

Claim 19 (Original). The method according to Claim 1,  
wherein mirroring further comprises:

10 synchronizing updates to overwrite the selected data object,  
and

synchronizing a later remote volume to overwrite the  
penultimate resulting first remote volume.

Claim 20 (Currently Amended). The method according to Claim  
1, wherein:

the storage space for the selected data object comprises a  
contents span selected from the group of contents spans  
5 consisting of a part of the contents, the whole contents, and  
more than the contents of the local storage device.

Claim 21 (Previously Presented). The method according to  
Claim 1, wherein mirroring further comprises:  
at the local storage device (SDL) at time  $t = 1$ :

Appln. No. 10/776,715  
Response dated September 11, 2007  
Reply to Office Action of June 11, 2007

setting a counter to  $s = 1$  and creating a local auxiliary

5 volume  $s$ ,

freezing the selected data object and comprising the local  
auxiliary volume  $s$  and the frozen selected data object into a  
resulting source volume  $s$ ,

10 permitting use of the frozen data object by allowing read  
and write operations associated with the resulting source volume  
 $s$ , and

at the at least one remote storage device:

creating at time  $t$  of a remote volume  $s$ , at least equal in  
size to the data object, and

15 starting from the time  $t$ :

copying the frozen data object from the resulting source  
volume  $s$  into the remote volume  $s$  until completion of copy,  
whereby the data object frozen at time  $t$  is mirrored in the at  
least one remote storage device.

Claim 22 (Currently Amended). The method according to Claim  
[[15]] 21, wherein mirroring further comprises:  
at the local storage device at time  $t = t + 1$  occurring after  
completion of copy to the at least one remote storage device:

- 5 a. increasing the counter to  $s = s + 1$ ,  
b. creating a local auxiliary volume  $s$ ,

Appln. No. 10/776,715  
Response dated September 11, 2007  
Reply to Office Action of June 11, 2007

c. freezing the resulting source volume s - 1, and  
comprising the local auxiliary volume s and the resulting source  
volume s - 1 into a resulting virtual volume s, and

10 d. permitting use of the selected data object by allowing  
read and write operations associated with the resulting source  
volume s, and

at the at least one remote storage device :

e. creating at time t of a remote volume s at least equal in  
15 size to the source volume, and  
starting from the time t:

f. copying the local auxiliary volume s - 1 from the  
resulting source volume s into the remote volume s and completing  
copy,

20 g. operating the second processing facility for  
synchronization, by overwriting, of the remote volume s onto the  
remote volume s - 1, and  
at the local storage device (SDL):

h. operating the first processing facility for  
25 synchronizing, by overwriting, of the local auxiliary volume s -1  
onto the selected frozen data object, and

repeating mirroring after completion of step f, by default  
repetition of the steps a to h, unless mirroring break is  
commanded.

Appln. No. 10/776,715  
Response dated September 11, 2007  
Reply to Office Action of June 11, 2007

Claim 23 (Previously Presented). The method according to  
Claim 22, wherein:

the local auxiliary volumes, the source volumes and the  
remote volumes are selected from the group consisting of volumes,  
5 virtual or logical volumes, and files.

Claim 24 (Original). The method according to Claim 22,  
further comprising:

storing in the at least one remote storage device at the  
time  $t$  of a complete mirrored copy of the selected data object  
5 comprising updates entered thereto at the time  $t - \Delta t$ .

Claim 25 (Currently Amended). A system for asynchronously  
mirroring a selected data object from at least one local storage  
device (SDL) into at least one remote storage device wherein the  
system comprises at least one local storage device, at least one  
5 remote storage device, a first processing facility and a second  
processing facility, the at least one remote storage device  
(SDRx), ~~the at least one local storage device~~ being coupled to  
the first processing facility (HL), and the at least one remote  
storage device being coupled to the second processing facility  
10 (HR), and where the at least one local storage device, the at

Appln. No. 10/776,715  
Response dated September 11, 2007  
Reply to Office Action of June 11, 2007

least one remote storage device, the first and the second processing facility are coupled to a network connectivity comprising pluralities of users, of processing facilities and of storage devices, the system further comprising:

15     ~~a device means~~ for carrying out a mirroring functionality running in the first and in the second processing facility, the mirroring functionality comprising:

        a freeze procedure being applied for freezing the selected data object at any desired instant in time as a source

20     ~~volume, [[and]]~~

        a copy procedure for copying the frozen selected data object into the at least one remote storage device, ~~simultaneously to the application of the freeze and copy procedure creating:~~

25     ~~a local auxiliary volume in the local storage device to which updates addressed to the frozen selected data object are redirected, a remote volume having a same size as the frozen source volume in the remote storage device, forming in the local storage device of a resulting source volume including the frozen~~  
30     ~~source volume and the local auxiliary volume, and copying the frozen source volume to the remote volume,~~

~~successively repeating the freeze and copy procedure by freezing the last created local auxiliary volume and~~

Appln. No. 10/776,715  
Response dated September 11, 2007  
Reply to Office Action of June 11, 2007

~~simultaneously creating a next local auxiliary volume to which~~  
35 ~~updates addressed to the frozen data are redirected, creating a~~  
~~next remote volume, and adding the last created local auxiliary~~  
~~volume to the last formed resulting source volume to form a new~~  
~~resulting source volume, and copying the before last frozen local~~  
~~auxiliary volume to the last created remote volume,~~  
40 the selected data object being used and updated in parallel  
to running of the mirroring functionality, and  
the mirroring functionality being run by default command,  
for copying updates to the selected data object, unless receiving  
command for mirroring break,  
45 whereby the selected data object residing in the at least one  
local storage device is copied and sequentially updated into the  
at least one remote storage device, ~~and whereby auxiliary volumes~~  
~~frozen by successive freeze procedures contain, respectively,~~  
~~successive updates directed to the data object wherein the~~  
50 mirroring functionality further comprises:  
the freeze procedure being applied for freezing the selected  
data object as a source volume,  
at least one local auxiliary volume to which updates  
addressed to the selected data object are redirected, the  
55 selected data object corresponding to one of the at least one  
local auxiliary volume,

Appln. No. 10/776,715  
Response dated September 11, 2007  
Reply to Office Action of June 11, 2007

at least one remote volume being created in each of the at least one remote storage device, to correspond to each one local auxiliary volume created,

60 a resulting source volume being formed in the at least one local storage device to comprise the frozen selected data object and the at least one local auxiliary volume, and

the copy procedure being applied for copying the frozen selected data object from the resulting at least one resulting  
65 source volume into the at least one remote storage device.

Claim 26 (Cancelled).

Claim 27 (Original). The system according to Claim 25, further comprising:

the mirroring functionality being applied simultaneously to more than one data object.

Claim 28 (Cancelled).

Claim 29 (Currently Amended). The system according to Claim [[26]] 25, further comprising:

the freeze procedure being applied for freezing simultaneously more than one data object.



Appin. No. 10/776,715  
Response dated September 11, 2007  
Reply to Office Action of June 11, 2007

Claim 30 (Currently Amended). The system according to Claim  
[[26]] 25, further comprising:

the copy procedure being applied to copy simultaneously more  
than one frozen selected data object.

Claim 31 (Currently Amended). The system according to Claim  
[[26]] 25, wherein the mirroring functionality  
further comprises:

a configuration for simultaneous mirroring of one single  
5 data object residing in one local storage device into more than  
one remote storage device.

Claim 32 (Currently Amended). The system according to Claim  
[[26]] 25, wherein the mirroring functionality further comprises:

a configuration for mirroring of more than one single data  
object simultaneously from one local storage device into one  
5 remote storage device.

Claim 33 (Currently Amended). The system according to Claim  
[[26]] 25, wherein the mirroring functionality further comprises:

Appln. No. 10/776,715  
Response dated September 11, 2007  
Reply to Office Action of June 11, 2007

a configuration for mirroring simultaneously a plurality of  
single data objects residing respectively in a same plurality of  
5 local storage devices into one remote storage device.

Claim 34 (Currently Amended). The system according to Claim  
[[26]] 25, wherein the mirroring functionality further comprises:  
a configuration for mirroring simultaneously a plurality of  
single data objects residing in one local storage device  
5 respectively into a plurality of remote storage devices.

Claim 35 (Currently Amended). The system according to Claim  
[[26]] 25, wherein the mirroring functionality further comprises:  
a configuration for mirroring simultaneously one single data  
object residing in each one local storage device out of a  
5 plurality of local storage devices into one remote storage  
device.

Claim 36 (Previously Presented). The system according to  
Claim 25, wherein mirroring further comprises:  
at a selected point in time:  
a mirroring cycle being started,  
5 the selected data object being frozen,

Appln. No. 10/776,715  
Response dated September 11, 2007  
Reply to Office Action of June 11, 2007

at least one local auxiliary volume (AVL) being created in the at least one local storage device and at least one remote volume (RV) being created in the at least one remote storage device,

10 at least one resulting source volume being formed to comprise the frozen selected data object and the local auxiliary volume, and

after the selected point in time:

15 the frozen selected data object being copied from the resulting source volume into the at least one remote volume until completion of copy,

the updates addressed to the selected data object being redirected to the local auxiliary volume,

20 use of the selected data object being permitted during mirroring, by allowing read and write operations associated with the resulting source volume, and

a next mirroring cycle being repeated by default command, after completion of copy to the at least one remote storage device, unless receiving command for mirroring break.

Claim 37 (Previously Presented). The system according to Claim 36, wherein mirroring further comprises:

Appln. No. 10/776,715  
Response dated September 11, 2007  
Reply to Office Action of June 11, 2007

a next mirroring cycle starting at a next point in time  
occurring after completion of copy to the at least one remote  
5 storage device, and

the resulting source volume being frozen,

an ultimate local auxiliary volume being created in the  
local storage device and an ultimate remote volume being created  
in the at least one remote storage device,

10 an ultimate resulting source volume being formed to consist  
of the penultimate resulting source volume and of the ultimate  
local auxiliary volume, and  
after the next point in time:

the penultimate local auxiliary volume being copied into the  
15 ultimate remote volume, and,

the updates addressed to the selected data object being  
redirected to the ultimate local auxiliary volume in the ultimate  
resulting source volume,

the selected data object being permitted for use during  
20 mirroring by allowing read and write operations associated with  
the ultimate resulting source volume and,  
after completion of copy into the ultimate remote volume:

the penultimate local auxiliary volume being synchronized  
into the frozen selected data object,

Appln. No. 10/776,715  
Response dated September 11, 2007  
Reply to Office Action of June 11, 2007

25 the at least one ultimate remote volume being synchronized  
into the penultimate remote volume by command of the second  
processing facility (HR), and

a next mirroring cycle being repeated, by default command  
after completion of copy to the at least one remote storage  
30 device (SDR), unless a command for mirroring break is received.

Claim 38 (Cancelled).

Claim 39 (Currently Amended). The system according to Claim  
[[38]] 36, wherein mirroring further comprises:

5 the at least one remote storage device storing a complete  
mirrored copy of the selected data object comprising updates  
entered thereto at the time when copy of the before to  
penultimate local auxiliary volume was completed.

Claim 40 (Original). The system according to Claim 25,  
further comprising:

the mirroring functionality being applicable to a data  
object selected from the group consisting of data volumes,  
5 virtual volumes, data files, system files, application programs,  
operation systems, data structures, and data base records.

Appln. No. 10/776,715  
Response dated September 11, 2007  
Reply to Office Action of June 11, 2007

Claim 41 (Original). The system according to Claim 25,  
further comprising:

the mirroring functionality being applicable to a network  
connectivity selected from the group consisting of local area  
5 networks, wide area networks and storage area networks.

Claim 42 (Original). The system according to Claim 25,  
further comprising:

the operation of the mirroring functionality being repeated  
at discrete repetition intervals of time defined as lasting at  
5 least as long as duration of copying of the ultimate local  
auxiliary volume to the ultimate remote volume.

Claim 43 (Original). The system according to Claim 25,  
further comprising:

the updates being synchronized to overwrite the selected  
data object, and  
5 a later remote volume being synchronizing to overwrite the  
penultimate resulting first remote volume.

Claim 44 (Currently Amended). The system according to Claim  
25, further comprising:

Appln. No. 10/776,715  
Response dated September 11, 2007  
Reply to Office Action of June 11, 2007

the storage space for the selected data object comprising a contents span selected from the group of contents spans  
5 consisting of a part of the contents, the whole contents, and more than the contents of the local storage device.

Claim 45 (Previously Presented). The system according to Claim 25, further comprising:

at the local storage device (SDL) at time  $t = 1$ :

a mirroring cycle counter being set to  $s = 1$  and a local  
5 auxiliary volume  $s$  being created,

the selected data object being frozen and comprising the local auxiliary volume  $s$  a resulting source volume  $s$  and the frozen selected data object into a resulting source volume  $s$ ,

the selected data object being permitted for use by allowing  
10 read and write operations associated with the resulting source volume  $s$ , and

at the at least one remote storage device:

a remote volume  $s$  being created at time  $t_0$  and being at least equal in size to the data object, and

15 starting from the time  $t$ :

the frozen data object being copied from the resulting source volume  $s$  into the remote volume  $s$  until completion of copy,

Appln. No. 10/776,715  
Response dated September 11, 2007  
Reply to Office Action of June 11, 2007

whereby the data object frozen at time  $t$  is mirrored in the at  
20 least one remote storage device.

Claim 46 (Previously Presented). The system according to  
Claim 45, further comprising:

at the local storage device at time  $t = t + 1$  occurring after  
completion of copy to the at least one remote storage device:

- 5 a. the mirroring cycle counter being increased to  $s = s + 1$ ,  
b. a local auxiliary volume  $s$  being created,  
c. the resulting source volume  $s - 1$  being frozen, and

comprising the local auxiliary volume  $s$  and the resulting source  
volume  $s - 1$  into a resulting source volume  $s$ , and

- 10 d. the selected data object being permitted for use by  
allowing read and write operations associated with the resulting  
local volume  $s$ , and

at the at least one remote storage device:

- e. a remote volume  $s$  being created at time  $t$  with a size at  
15 least equal to the size of the source volume, and  
starting from the time  $t$ :

f. the local auxiliary volume  $s - 1$  being copied from the  
resulting source volume  $s$  into the remote volume  $s$  until copy  
completion,



Appln. No. 10/776,715  
Response dated September 11, 2007  
Reply to Office Action of June 11, 2007

20 g. the second processing facility being operated for  
synchronization, by overwriting, of the remote volume s onto the  
remote volume s - 1, and  
at the first storage device (SDL):

h. the first processing facility being operated for  
25 synchronization, by overwriting, of the local auxiliary volume  
s -1 onto the frozen selected data object, and  
mirroring being repeated after completion of step f, by  
default repetition of the steps a to h, unless mirroring break is  
commanded.

Claim 47 (Previously Presented). The system according to  
Claim 46, further comprising:

the local auxiliary volumes, the source volumes and the  
remote volumes being selected from the group consisting of  
volumes, virtual or logical volumes, and files.

Claim 48 (Original). The system according to Claim 46,  
further comprising:

a complete mirrored copy of the selected data object  
comprising updates entered thereto at the time t - 2 being stored  
5 in the at least one remote storage device at time t.